DIVISION OF RESEARCH, INNOVATION & SYSTEM INFORMATION
Research Initial Scope of Work
SUBMITTAL FORM - FY 15/16

I. Project Number: P993
Project Title: Estimating Service Life for Steel Pipe in Non-Abrasive Environments

II. Task Number: 2895
Task Title: Determine Accuracy of Service Life Prediction Equation

III. Project Problem Statement:

Determine the accuracy of the existing service life prediction equation for corrugated steel pipe (CSP), i.e., the years to first perforation equation for CSP currently used by Caltrans designers. See Highway Design Manual (HDM) Figures 855.3A, 855.3B and California Test Method 643 (http://www.dot.ca.gov/hq/esc/ctms/pdf/CT_643.pdf).

IV. Objective:
The objective of this research is to verify the accuracy of the existing culvert service life prediction equation for CSP that was developed in the late 50's and early 60's.

Because of the relatively small number of culverts studied in the 2014 pilot study and in order to substantiate the results, a significantly more comprehensive research effort is needed. The results from the pilot study indicated that the existing culvert service life prediction equation for CSP (i.e., the years to first perforation equation used for metal pipe in HDM Figures 855.3A, 855.3B) is generally predicting equal to, or higher than the measured or known wear rate.

V. Task Description of Work and Expected Deliverables:

A. Office Data Collection
Using as-built plans, Caltrans Maintenance Culvert Inspection database, and existing corrosion data, develop a statewide candidate list of steel culverts representative of California's geography and climatic diversity. The total number of culverts to be studied must not be less than 500. Each culvert must be at least 10 years old. Evaluate abrasion level based on HDM Table 852A and exclude pipes with an abrasion level of 4 or higher. Where existing corrosion data is not available, it must be collected in the field using California Test Method 643.

B. Field Data Collection
1. Evaluate for perforation (visual & pick hammer) for a minimum of three zones and three corrugation crests to be cleaned with a wire brush.
2. Obtain thickness measurements using an ultrasonic thickness gage (Olympus Model 26MG - accuracy of +/-0.002 in.) or equivalent. A minimum of two invert readings must be made at the inlet and outlet of nonhuman entry culverts and a

minimum of three invert readings (one mid-barrel) must be made where human entry is possible. Each measurement must be made on the corrugation crest at the 6 o' clock barrel location. Calibrate original culvert thickness at 3 or 9'o' clock.

3. When needed, collect corrosion data (pH and minimum resistivity) using California Test Method 643.
4. Verify abrasion level based on HDM Table 852A is non-abrasive (i.e., level 1-3)

Develop a final report using the same format as the Caltrans pilot study (including Appendixes A & B) with recommendations using the results of this study. Compare the results with the Caltrans Pilot and Stratfull studies. Write a conclusions and recommendations section.

VI. Background:

1. Stratfull[1] Studies (1955 – 1962)

Prior to 1955, the history of corrugated metal pipe design in California was punctuated with predictions of service life varying from 10 years to 100 years. These predictions of the anticipated service life of such pipe as employed in highway drainage structures were not estimated without some foundation of "field experience". However, the results of inspecting approximately 7,000 metal culverts in a portion of northern California indicated that the previously estimated service life of 10 or 100 years would depend on (1) the fundamental factors of abrasion and corrosion and (2) the geographic location in which the "experience" was accumulated.

In 1959 the California Division of Highways reported on findings of a corrosion survey of 7,000 corrugated metal culverts located in one area of California (District 1). Based on that data supplemented by additional information collected during statewide investigations, a survey technique (California Test Method 643) was developed to estimate the corrosion potential of proposed culvert sites. The results of the 1959 study clearly indicated that the corrosion rate of metal culverts was a variable depending on the environment.

By utilizing the information from the first study and supplementing it with data from different types of watersheds located in various parts of the State, Stratfull's assessment, based on what he could evaluate and test for at the time, led him to identify that hydrogen-ion concentration (pH) and the electrical resistivity of the soil and waters were major contributors to deterioration, and that a method for estimating deterioration could be developed based on these parameters.
Stratfull's studies provided the basis for the present day HDM Figures 855.3A, 855.3B and California Test Method 643.

[1] Dick Stratfull, Corrosion Engineer, California Division of Highways Materials and Research Department, Sacramento.

2. Office of Highway Drainage Design Pilot Study (2014)

To determine the accuracy of Stratfull's service life prediction equation, seven sites were selected throughout Northern California to represent as much geographical, topographical and climatic diversity as possible. Six of these sites were selected from corrosion data from projects furnished by District Materials Branches. As-built plans were compiled for both these projects and earlier contracts within the project limits. A seventh site was included (03-Ed-50 PM 14.0) using comprehensive information previously gathered for a culvert repair project involving this Office in 2003. The total number of culverts studied was 44. At some sites the original culvert had either been replaced, or extended at least once. All extensions were measured independently. The total number of culverts (including extensions) actually measured or observed for first perforation was 28. All replaced culverts were assumed to have reached first perforation.

The results from the pilot study indicated that the existing culvert service life prediction equation for CSP (i.e., the years to first perforation equation used for metal pipe in HDM Figures 855.3A, 855.3B) is generally predicting equal to, or higher than the measured or known wear rate. The conclusion stated California Test Method 643 may be overly conservative. However, no changes to the existing equation were recommended based on this study. It was determined that further research using the same methodology with a much larger sub-set of culverts from various geographical locations statewide was needed to verify the conclusion.

VII. Estimate of Duration: 24 to 36 months

VIII. Related Research: A Preliminary Investigation is underway.

IX. Deployment Potential:

Data developed by Caltrans based on previous research is being used nationally. New data will allow Caltrans to better estimate life expectancy of pipes.

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